Doctor of Philosophy Program in Polymer Science and Engineering
(International Program/Revised Program 2018)

Department of Materials Science and Engineering

Title of program

Thai	หลักสูตรปรัชญาดุษฎีบัณฑิต สาขาวิชาวิทยาการและวิศวกรรมพอลิเมอร์ (หลักสูตรนานาชาติ)
English	Doctor of Philosophy Program in Polymer Science and Engineering (International Program)

Title of degree

Thai	ปรัชญาดุษฎีบัณฑิต (วิทยาการและวิศวกรรมพอลิเมอร์) ปร.ด. (วิทยาการและวิศวกรรมพอลิเมอร์)
English	Doctor of Philosophy (Polymer Science and Engineering) Ph.D. (Polymer Science and Engineering)

Place of instruction

Faculty of Engineering and Industrial Technology, Silpakorn University, Sanamchandra Palace Campus, Nakhon Pathom

Objectives

1. To produce Ph.D. graduates capable of defining and solving problems in Polymer Science and Engineering by producing high quality research contributing to basic knowledge or creating new knowledge in Polymer Science and Engineering to benefit the development of the country.
2. To create Ph.D. graduates with research skills, who are creative and capable of making decisions, and who have advanced research skills, management skills, and the characteristic of life-long learning.

Admission requirements

1. Admission requirements classified by study plan as follows:
   1.1 **Type 1.1** Thesis equivalent to 48 credits
   The applicants must possess a Master of Engineering degree in Polymer Science and Engineering or equivalent degree with permission from the Department of Materials Science and Engineering, Silpakorn University.
   1.2 **Type 1.2** Thesis equivalent to 72 credits
   The applicants must possess a Bachelor of Engineering degree with honors in Petrochemicals and Polymeric Materials or equivalent degree with permission from the Department of Materials Science and Engineering, Silpakorn University.
   1.3 **Type 2.1** Thesis equivalent to 36 credits and 12 additional course credits
   The applicants must possess a Master of Engineering degree in Polymer Science and Engineering or equivalent degree with permission from the Department of Materials Science and Engineering, Silpakorn University.
   1.4 **Type 2.2** Thesis equivalent to 48 credits and 27 additional course credits
   The applicants must possess a Bachelor of Engineering degree with honors in Petrochemicals and Polymeric Materials or equivalent degree with permission from the Department of Materials Science and Engineering, Silpakorn University.
2. Applicants must have other qualifications as required in accordance with Silpakorn University's regulations on graduate study, B.E. 2550, Title 7 and/or any revisions thereto.

3. Applicants must have test scores in accordance with the regulation of the Higher Education Commission or in accordance with the announcement of Silpakorn University on English comphrensive standards for Ph.D. candiates of Silpakorn University, B.E. 2560 and/or any revisions thereto.

4. Applicants must have other qualifications as required by the Department of Materials Science and Engineering.

Program structure

Doctor of Philosophy Program in Polymer Science and Engineering offers four options for program structure: Type 1.1, Type 1.2, Type 2.1 and Type 2.2 as

1. Type 1.1 Thesis: Ph.D. students who have a master's degree

Seminar (non-credit)	1	credit
Research skills (non-credit)	1	credit
Thesis (equivalent to)	48	credits
Total credits for the program equivalent to	48	credits

2. Type 1.2 Thesis: Ph.D. students who have a bachelor's degree with honor

Research methodology (non-credit)	2	credits
Seminar (non-credit)	2	credits
Research skills (non-credit)	1	credit
Thesis (equivalent to)	72	credits
Total credits for the program equivalent to	72	credits

3. Type 2.1 Thesis and Coursework: Ph.D. students who have a master's degree

Seminar (non-credit)	1	credit
Research skills (non-credit)	1	credit
Compulsory courses	6	credits
Elective courses (at least)	6	credits
Thesis (equivalent to)	36	credits
Total credits for the program at least	48	credits

4. Type 2.2 Thesis and Coursework: Ph.D. students who have a bachelor's degree with honor

Research methodology (non-credit)	2	credits
Seminar (non-credit)	2	credits
Research skills (non-credit)	1	credit
Compulsory courses	21	credits
Elective courses (at least)	6	credits
Thesis (equivalent to)	48	credits
Total credits for the program at least	75	credits

Ph.D. students, who have a bachelor's degree in other related fields equivalent to the Petrochemical and Polymeric Materials program, or who have a master's degree in other related fields equivalent to the Materials Science and Engineering program must take fundamental courses in the bachelor's degree program in Petrochemicals and Polymeric Materials or master's degree program in Polymer Science and Engineering with the consent of the admission committee of Department of Materials Science and Engineering as non-credits courses.

Courses

1. Type 1.1 Thesis: Ph.D. students who have a master's degree

1.1 Seminar (non-credit) 1 credit

622 791	Seminar in Polymer Science and Engineering II	1(0-2-1)

1.2 Research skills (non-credit) 1 credit

622 792	Research Skills	1(0-2-1)

1.3 Thesis (equivalent to) 48 credits

622 793	Thesis	equivalent to 48 credits

2. Type 1.2 Thesis: Ph.D. students who have a bachelor's degree with honors

2.1 Research methodology (non-credit) 2 credits

622 591	Research Methodology	2(2-0-4)

2.2 Seminar (non-credit) 2 credits

622 592	Seminar in Polymer Science and Engineering I	1(0-2-1)
622 791	Seminar in Polymer Science and Engineering II	1(0-2-1)

2.3 Research skills (non-credit) 1 credit

622 792	Research Skills	1(0-2-1)

2.4 Thesis (equivalent to) 72 credits

622 794	Thesis	equivalent to 72 credits

3. Type 2.1 Thesis and Coursework: Ph.D. students who have a master's degree

3.1 Seminar (non-credit) 1 credit

622 791	Seminar in Polymer Science and Engineering II	1(0-2-1)

3.2 Research skills (non-credit) 1 credit

622 792	Research Skills	1(0-2-1)

3.3 Compulsory courses: 6 credits including the following courses

622 711	Special Topics in Polymer Science	3(3-0-6)
622 721	Special Topics in Polymer Engineering	3(3-0-6)

3.4 Elective courses: at least 6 credits from the following courses

622 712	Smart Polymers	3(3-0-6)
622 713	Polymeric Composites	3(3-0-6)
622 714	Polymeric Nanomaterials	3(3-0-6)
622 715	Polymeric Material Systems Selection	3(3-0-6)
622 716	Conductive Electroactive Polymers	3(3-0-6)
622 722	Polymer Process Machinery Technology	3(2-2-5)
622 723	Mold Design	3(2-2-5)
622 724	Plastic Production Design	3(2-2-5)
622 725	Additive Manufacturing	3(2-2-5)
622 731	Special Topics in Polymer Properties	3(3-0-6)
622 781	Selected Topics in Advanced Polymer Science and Engineering I	3(3-0-6)

622 782	Selected Topics in Advanced Polymer Science and Engineering II	3(3-0-6)

3.5 Thesis (equivalent to) 36 credits

622 795	Thesis	equivalent to 36 credits

4. Type 2.2 Thesis and Coursework: Ph.D. students who have a bachelor's degree with honor

4.1 Research methodology (non-credit) 2 credit

622 591	Research Methodology	2(2-0-4)

4.2 Seminar (non-credit) 2 credit

622 592	Seminar in Polymer Science and Engineering I	1(0-2-1)
622 791	Seminar in Polymer Science and Engineering II	1(0-2-1)

4.3 Research skills (non-credit) 1 credit

622 792	Research Skills	1(0-2-1)

4.4 Compulsory courses: 21 credits including the following courses

622 511	Advanced Polymer Synthesis	3(3-0-6)
622 512	Polymer Physics	3(3-0-6)
622 513	Advanced Polymer Characterization	3(3-0-6)
622 521	Applied Mathematical Methods for Polymer Engineering	3(3-0-6)
622 522	Advanced Rheology and Polymer Processing	3(3-0-6)
622 711	Special Topics in Polymer Science	3(3-0-6)
622 721	Special Topics in Polymer Engineering	3(3-0-6)

4.5 Elective courses: at least 6 credits from the following courses

622 712	Smart Polymers	3(3-0-6)
622 713	Polymeric Composites	3(3-0-6)
622 714	Polymeric Nanomaterials	3(3-0-6)
622 715	Polymeric Material Systems Selection	3(3-0-6)
622 716	Conductive Electroactive Polymers	3(3-0-6)
622 722	Polymer Process Machinery Technology	3(2-2-5)
622 723	Mold Design	3(2-2-5)
622 724	Plastic Production Design	3(2-2-5)
622 725	Additive Manufacturing	3(2-2-5)
622 731	Special Topics in Polymer Properties	3(3-0-6)
622 781	Selected Topics in Advanced Polymer Science and Engineering I	3(3-0-6)
622 782	Selected Topics in Advanced Polymer Science and Engineering II	3(3-0-6)

4.6 Thesis (equivalent to) 48 credits

622 796	Thesis	equivalent to 48 credits

Course Descriptions

622 511 Advanced Polymer Synthesis 3(3-0-6)

Rate expression and molecular weight control in step-growth and chain-addition polymerizations. Copolymerization reactions and control of their monomer sequence in copolymer chains. Polymerization reaction systems and systems used in industries. Emulsion polymerization systems, rate and molecular weight control, and their application for industry. Control/living radical polymerization. Metathesis polymerization. Group transfer polymerization. Plasma polymerization. Sonochemical polymerization. Synthesis of silicone polymers. Case studies of new polymer synthetic processes.

622 512 Polymer Physics 3(3-0-6)

Conformations of ideal and real polymer chains. Dynamics of polymer molecules. Linear viscoelasticity of polymers. Physics of amorphous and crystalline polymers. Transition temperature and free volume of polymers. Elastic properties of rubber materials. Case studies of current research in polymer physics.

622 513 Advanced Polymer Characterization 3(3-0-6)

Relationship between polymer morphology, processing and property. Techniques for polymer molar mass determination. Characterization of polymers using thermal analysis. Morphological investigations using microscopy techniques. Application of techniques in spectroscopy and x-ray diffraction in polymer characterization. Techniques for dynamics characterization of polymers. Practical interpretation of polymer characterization data. Case studies of current research in polymer structural analysis by polymer characterization.

622 521 Applied Mathematical Methods for Polymer Engineering 3(3-0-6)

Mathematical principles for understanding and solving engineering problems in polymer studies. Analytical methods in polymer processing including stress-strain analysis in solids. Case studies of fluid mechanics concerning rheology, mass and energy transport equations, viscoelastic properties related to polymer processing. Mathematic models. Applications of mathematical equations in polymer processing including extrusion and injection molding.

622 522 Advanced Rheology and Polymer Processing 3(3-0-6)

Relationships between stress and strain in tensor equations for elastic solids and Newtonian fluids. Rheological models of non-Newtonian fluids. Theoretical basis of capillary and rotational rheometer. Practical interpretation of rheological data. Application of rheological model and continuum mechanics in extrusion, injection molding, blown film extrusion, and calendaring. Case studies of rheological model for screw and die design.

622 591 Research Methodology 2(2-0-4)

Condition: This course is evaluated as S/U.

Researchers' code of ethics. Creative thinking and problem-solving. Research concepts and examples of research. Systematic approaches to conducting research and the importance of each step in conducting successful research. Topic selection. Experimental design. Data collection. Analysis of data using quantitative and qualitative approaches. Research proposal preparation. Research report preparation. Presentation techniques. Analytical skills for defense. Publication of research. Abstract writing. Skills development in the use of research instruments.

622 592 Seminar in Polymer Science and Engineering I 1(0-2-1)

Condition: This course is evaluated as S/U.

Comprehensive article reading. Compilation of information from interesting and up-to-date research articles in the field of Polymer Science and Engineering. Composition content from selected research articles for presentation in English in the class. Researcher's ethics and etiquette in citing references for presentations. Compulsory seminar attendance and submission of a full report.

622 711 Special Topics in Polymer Science 3(3-0-6)

Synthesis and characteristics of new polymers appearing in the research literature and being commercialized in the plastics industry.Liquid crystalline polymers. Functionalized polymer blends. Thermoplastic elastomers. Oligomerically-modified nanocomposites. Physical and thermal characterization of new polymers. New polymers and new techniques in polymer preparations.

622 712 Smart Polymers 3(3-0-6)

Polymers responding to excitation by changing their physical properties, as a period in the current research literature. Electro-rheological and magneto-rheological fluids. Smart gels. Positive thermal coefficient. Electrospun fibers. Shape memory polymer alloys. Piezoelectric polymers. Nonlinear optical polymers.

622 713 Polymeric Composites 3(3-0-6)

New polymeric composites appearing in the current research literature. New polymeric composites in terms of their composition, morphology, properties, and applications. Innovations in the fabrication process for new polymeric composites.

622 714 Polymeric Nanomaterials 3(3-0-6)

Polymeric nanomaterials appearing in the current research literature. Polymeric nanomaterials in terms of their preparation, structure, properties, and applications.

622 715 Polymeric Material Systems Selection 3(3-0-6)

Polymeric material system selection appearing in the current research literature. Screening of potential polymers. Recording of polymer performance. Selection of polymers based on priority performance requirements. Comparing and contrasting potential polymers. Evaluation of process demand and post-fabrication schemes.

622 716 Conductive Electroactive Polymers 3(3-0-6)

Electrical properties of polymers appearing in the current research literature. Structure and functionally modified conductive electroactive polymers in terms of their synthesis, properties, and applications.

622 721 Special Topics in Polymer Engineering 3(3-0-6)

New plastic processing techniques appearing in the research literature and currently being commercialized in the plastics industry. Multi-material injection molding technology. Multi-layer material technology. Advanced blow molding. Theory and design of polymer processing machinery. Hydraulic and electrical control circuits. Machine logic. Drives. Pumps and motors. Barrel and screw combinations.

622 722 Polymer Process Machinery Technology 3(2-2-5)

New polymer processing machinery presented at world-class exhibitions. Review of critical features of new polymer processing machinery launched by leading companies in the plastics industry in the last five years. Comparison of advantages, improvements, and limitations of new machinery.

622 723 Mold Design 3(2-2-5)

New materials for mold construction, machining operations, developments in rapid tooling, methods of mold repair, developments in hot runners, and special tooling. Use of computer-aided engineering and design in mold design and construction. Case studies of mold design.

622 724 Plastic Production Design 3(2-2-5)

Design of new polymer products made from polymers, applying the total systems approach to the balance between product design, choice of materials, and process technique. Use of computer-aided engineering and design in product design and the analysis of product performance. Case studies of plastic production design.

622 725 Additive Manufacturing 3(2-2-5)

Three-dimensional solid object manufacturing. Advanced laminated object manufacturing. Advanced stereolithography. Advanced selective laser sintering. Advanced fused deposition modeling. Computer-aided manufacturing. Segmented and layered graphical data ganerating. Plastic prototype manufacturing. Criteria analysis of plastic prototypes.

622 731 Special Topics in Polymer Properties 3(3-0-6)

New techniques to evaluate polymer properties appearing in the research literature and being commercialized in the plastics industry. Dynamic mechanical analyzer. Moving die rheometer. Empirical, semi-empirical, and theoretical methods for determining polymer properties by refractive index, density, glass-transition temperature, modulus, and compatibility. Advanced techniques for predicting the engineering and physical properties of polymers from molecular structures.

622 781 Selected Topics in Advanced Polymer Science and Engineering I 3(3-0-6)

Current selected topics of interest in Advanced Polymer Science and Engineering.

622 782 Selected Topics in Advanced Polymer Science and Engineering II 3(3-0-6)

Current selected topics of interest in Advanced Polymer Science and Engineering. Not the same as described in 622 781 Selected Topics in Advanced Polymer Science and Engineering I.

622 791 Seminar in Polymer Science and Engineering II 1(0-2-1)

Condition: This course is evaluated as S/U.

Comprehensive article reading. Compilation of information on interesting and current topics in the field of Polymer Science and Engineering to give presentations and organize a seminar in related topics. Compulsory seminar attendance. Submission of a full report.

622 792 Research Skills 1(0-2-1)

Condition: This course is evaluated as S/U.

Research skills development. Skills training on the use of scientific tools in Polymer Science. Skills training on the use of machinery in Polymer Engineering. Experience training through using innovative experiments in Polymer Science and Engineering. Plastics testing standards.

622 793 Thesis equivalent to 48 credits

Individual research thesis under supervision in the field of Polymer Science and Engineering for type 1.1 students.

622 794 Thesis equivalent to 72 credits

Individual research thesis under supervision in the field of Polymer Science and Engineering for type 1.2 students.

622 795 Thesis equivalent to 36 credits

Individual research thesis under supervision in the field of Polymer Science and Engineering for type 2.1 students.

622 796 Thesis equivalent to 48 credits

Individual research thesis under supervision in the field of Polymer Science and Engineering for type 2.2 students.

Graduation requirements

Graduation will be in accordance with Silpakorn University's regulations on graduate study, B.E. 2550, and/or any revisions thereto with additional requirements of the Faculty of Engineering and Industrial Technology. The graduates of the Doctor of Philosophy in Polymer Science and Engineering (International Program) must satisfy the following criteria:

1. The period of study must not exceed six academic years for type 1.1 and type 2.1 and must not exceed eight academic years for type 1.2 and type 2.2.
2. The graduates must complete all courses with the required cumulated credits according to each program plan.
3. Type 2.1 and 2.2 graduates must achieve an accumulated grade point average of at least 3.00 with at least B or S in all courses.
4. The graduates must pass the qualifying examination.
5. The graduates must successfully defend their own Ph.D. thesis in front of an examination committee which consists of internal and external professional scholars. The examination committee is appointed by the Graduate School. Silpakorn University. The examination must be open to the public. The graduates must submit a thesis in the format approved by the Graduate School, Silpakorn University.
6. Thesis or a part of the thesis of the Ph.D. students for type 1.1 and 1.2 must be published or at least be accepted for publication in a peer-reviewed national or international academic journal in accordance with the announcement of committee of higher education commission on the guildlines of the published academic journal for at least two papers and at least one presentation at an international conference.

The thesis or a part of the thesis of the Ph.D. students for type 2.1 and 2.2 must be published or at least be accepted for publication in a peer-reviewed national or international academic journal in accordance with the announcement of committee of higher education commission on the guildlines of the published academic journal for at least one paper and at least one presentation at an international conference.

7. The graduates must obtain S on the English examination conducted by Silpakorn University as part of the admission test or have an exemption on the foreign language test in accordance with Silpakorn University's regulations on graduate study, B.E. 2550, category 5, title 32.2 and/or any revisions thereto.

8. The graduates must fulfill all requirements in accordance with Silpakorn University's regulations on graduate study, B.E. 2550, category 7 and/or any revisions thereto.